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Galerkin Method in the Gravitational Collapse: a Dynamical System Approach

H. P. De Oliveira Henrique@Fnal.Gov Nasa/Fermilab Astrophysics Center

I. Damião Soares ivano@cbpf.br *Centro Brasileiro de Pesquisas Físicas*

abstract We study the general dynamics of the spherically symmetric gravitational collapse of a massless scalar field. We apply the Galerkin projection method to transform a system of partial differential equations into a set of ordinary differential equations for modal coefficients, after a convenient truncation procedure, largely applied to problems of turbulence. In the present case, we have generated a finite dynamical system that reproduces the essential features of the dynamics of the gravitational collapse, even for a lower order of truncation. Each initial condition in the space of modal coefficients corresponds to a well definite spatial distribution of scalar field. Numerical experiments with the dynamical system show that depending on the strength of the scalar field packet, the formation of black-holes or the dispersion of the scalar field leaving behind flat spacetime are the two main outcomes. We also found numerical evidence that between both asymptotic states, there is a critical solution represented by a limit cycle in the modal space with period $\Delta u \approx 3.55$.

$2M/r$

